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(54) Imaging method and apparatus.

(57) A method for generating a latent image on a substrate surface using a low current (e.g. less than 2 × 10⁻³ amperes) electrical discharge. The apparatus may include a movable carriage or roll (10) adapted to support a coated plate (20) and move it past an imaging assembly (30). The discharge is maintained by a voltage source (60) controlled by switching means (65) in response to a pattern data processor (55). The invention may be used, for example, to image lithographic plates, which plates may or may not contain a light-sensitive material, from a digital source of image data.

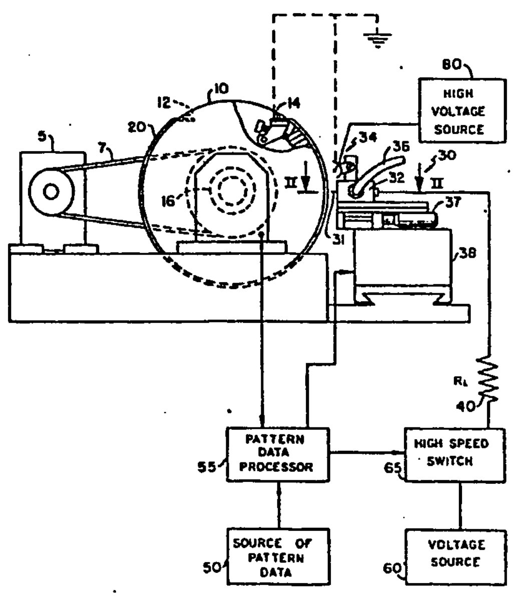

FIG. - 1 -

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Croydon Printing Company Ltd.

IMAGING METHOD AND APPARATUS

This invention relates to a method for imaging a substrate having a coating thereon which is transformable by means of a relatively low current electrical discharge. In one embodiment, this invention relates to a method whereby commonly available lithographic printing plates may be electronically imaged inexpensively, and subsequently used in conventional lithographic printing processes without requiring a conventional photocomposition or photo-typesetting step.

BACKGROUND OF THE INVENTION

In most lithographic printing systems in use today, the lithographic printing plate is imaged by means of a photographic process during which a photographically-generated film positive or negative transparency carrying the desired image is first prepared and then projected onto or exposed in contact with the light sensitive surface of the plate. In certain systems the plate may be exposed directly by the original copy without the need for an intermediate film transparency (i.e., by reflection), but such systems still require the initial preparation of "camera-ready" copy.

Attempts have been made to eliminate the need for art and copy preparation, as well as the need for various photoconversion process steps, by generating an image carrier, i.e., an imaged lithographic printing plate, directly from electronically stored or generated data. Such systems may, for example, rely upon a laser beam which impinges upon a light sensitive plate surface, or rely upon an electrical spark or arc, or other source of energy, which removes one or more layers of material from the surface of a lithographic-type plate, often a plate having a special construction, or may use electrostatic charges to define the desired image.

Lithographic plate imaging systems of these types frequently have significant shortcomings, among the most significant being one or more of the following: the relative complexity and therefore high cost and low

reliability of the apparatus necessary to implement these systems, and the high cost of the specially formulated and prepared lithographic plates which generally must be used in such systems or the generally low quality of the resulting printed image.

The process of this invention overcomes these disadvantages by providing an efficient, inexpensive system for generating, for example, an image of extremely high quality on a variety of relatively inexpensive diazonium resin lithographic plates of conventional design, without the need for specialized plate coatings, or the need for photocomposition, "camera-ready" art or copy preparation, or photoconversion steps, and preferably using image data which is electronically generated or stored. Photopolymer or other plates may also be imaged using the techniques herein, although diazonium resin-type plates are generally preferred. A relatively low current electrical discharge is used to produce a latent image capable of conventional image development on the plate surface by inducing a chemical change in the material found on the face of the plate which changes the relative solubility of the plate coating in the areas traced by the discharge, without displacing or removing significant quantities of the coating material as is usually done with spark-type systems, and without relying upon photo-induced processes commonly encountered in laser systems.

A detailed description of the invention follows, in which reference is made to the Figures summarized below.

Figure 1 schematically depicts an apparatus which may be used to image a printing plate, in accordance with the teachings of this invention.

Figure 2 is a section view of the apparatus shown in Figure 1, taken along the lines II-II, showing details of the stylus assembly;

Figure 3 is a section view of the stylus assembly of Figure 2, taken generally along the lines III-III;

Figure 4 is a schematic diagram of a switching circuit which may be used in connection with this invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

An apparatus and process embodying this invention as applied to plates commonly used in conventional offset lithography are schematically depicted in Figure 1. Roll 10 serves as a support for conventional lithographic plate 20. Appropriate securing means 12, 14 may be employed to attach plate 20 securely to roll 10 during the imaging process described below. Means 12, 14 may be any means capable of attaching and holding a lithographic plate of conventional design on a roll surface, such as, for example, means employing an array of tapered pins as is used by many offset lithographic press manufacturers to attach and secure lithographic plates having a row of holes for accommodating the pins along each end. It is preferred that the plate itself be at least moderately electrically conductive, so that the plate may be electrically grounded during the imaging process. To facilitate the grounding arrangement, means 12, 14 may be designed to afford a grounding path from the plate 20, as, for example, by electrically grounding roll 10 and ensuring that means 12, 14 are in electrical contact with both the roll 10 and the conductive plate 20. Other arrangements for electrically grounding the plate 20 may be used as well.

To facilitate placing the desired latent image on the roll, roll 10 may be rotated by means of motor 5 and belt drive 7. Angular displacement sensor 16 may also be associated with roll 10. Such sensor may be used to indicate the precise rotational position of roll 10, and is particularly desirable if the pattern is to be placed on the plate automatically by electronic means, as is discussed below.

Opposite the surface of roll 10 and plate 20 is positioned electrical imaging assembly 30. In the embodiment depicted in Figure 1, assembly 30

is comprised of: (1) electrically conductive stylus assembly 32, including an electrode or stylus 31 for establishing an electrical discharge within a discharge region between electrode or stylus 31 and the opposing surface of plate 20, (2) gas means 36 for supplying the discharge region with a gas, and (3) ionization promotion means 34 directed into the discharge region between the tip of stylus 31 and the opposing surface of plate 20. A primary function of electrical imaging assembly 30 is to establish and interrupt, or modulate, in accordance with externally supplied pattern information, an electrical discharge within the region between the surface of plate 20 and the tip of stylus 31 capable of forming a latent image on the surface of plate 20 in accordance with the teachings herein.

Varying the intensity of the discharge, such as by varying the electrical current in the discharge and thereby introducing variations in the chemically transformed areas on the surface of plate 20, is also contemplated. It is foreseen that the intensity may be varied within the ranges specified herein by varying the current supplied to a pre-existing discharge, or by rapidly initiating and terminating a discharge with the desired current level.

Stylus 31 may be constructed of any suitable electrically conductive material. Preferably, stylus 31 is comprised of a material which is not susceptible to excessive wear when used as an electrode during the imaging process, such as, for example, steel. Tip radii of from about 0.0005 inch to about 0.001 inch have been used with success; it is foreseen other tip radii outside this range may be advantageous in certain applications. Stylus 31 may be partially encased in a sheath of a protective, electrically insulating material, depicted at 33 in Fig. 3, to electrically isolate and facilitate handling and positioning of the stylus tip.

The tip of stylus 31 is preferably positioned radially perpendicular to the surface of plate 20, at a distance ranging from about 0.001 inch to

about 0.010 inch, although it should be emphasized that greater or lesser distances are known to be operable. Hereinafter, the immediate region between the tip of stylus 31 and the opposed surface of plate 20 shall be referred to as the discharge gap. To facilitate scanning of the stylus across the face of plate 20, the stylus may be attached to a translating stage 38 capable of precisely controllable motion along the rotational axis of roll 10; data specifying the relative position of stage 38 is preferably made available to a pattern data processor to facilitate the relative position of stylus 31 over the surface of plate 20 and to assure proper synchronization of the flow of pattern data to the stylus to maintain accurate image re-creation on the plate surface.

Gas means 36 serves as a source for inserting sufficient quantities of an ionizable gas which is relatively inert with respect to the plate surface in the absence of an electric discharge into the discharge gap. In an elementary form, it need be nothing more than the open end of a section of hollow tubing, leading from a source of the desired gas, having an end which is positioned near and directed toward the discharge gap. Of course other, more elaborate means may be employed if desired or found advantageous. Shown in detail in Figures 2 and 3, stylus 31 may be mounted in a collar 33 in which a small gas passage may be provided adjacent and parallel to the axis of stylus 31 to provide localized placement of the desired gas in the vicinity of the stylus tip. Among others, commercially available relatively inert gases distributed for spark chamber applications have been found generally suitable and satisfactory. Such gases can have helium and neon as principal constituents. The presence of oxygen in the discharge gap appears to inhibit the imaging process of this invention.

Ionization or breakdown promotion means 34 may be any means which is found effective in promoting electrical breakdown of the gas in the discharge gap. In one embodiment of the invention, means 34 may be a

shielded corotron device, comprising a short section of tungsten wire positioned within a semi-cylindrical, electrically grounded shield. The wire is impressed with a relatively high negative voltage (on the order of kilovolts) at relatively low current (on the order of milliamps), for example, from high voltage source 80. Such corona discharge devices are commonly employed in electrostatic copying machines as an ion source for charging the xerographic plate. It is believed that use of such means 34 can minimize certain time lags associated with electrical discharges in gases by acting as a source or generator of free electrons or negative ions which initiate the subsequent secondary ionization processes ultimately responsible for the avalanche behavior leading to breakdown. By use of such means 34, the time lag between the application of the requisite electrical potential between the stylus and the plate and the establishment of the electrical discharge induced thereby (indicating breakdown has occurred) may be reduced dramatically. It should be noted that the voltage necessary to initiate such breakdown is lowered by the action of means 34 as well. A relatively low-powered ultraviolet light source directed into the discharge region and not shining directly on the plate surface may be used in place of the corotron. Optionally, no ionization or breakdown promotion means need be employed.

It is believed that the electrical discharge phenomenon utilized in this invention is separate and distinct from the arc or spark discharge phenomena described in the literature. Much of the literature addresses electrical discharge phenomena which occur at low or extremely low pressures, and wherein a relatively large anode is positioned at a substantial distance from a relatively large cathode. In the instant invention, however, the electrical discharge may occur at or near atmospheric pressure, and occurs between a needle-like stylus and a substantially flat plate, with a gap spacing of only perhaps 0.001 to 0.010

inch or so. Typical time-averaged electrical current values may range from about $2x10^{-6}$ amperes to about $2x10^{-3}$ amperes, although operation above this range, but below the spark discharge regime, may be preferred under some conditions. With commonly available diazonium resin plates, time averaged current values within the range of from about $2x10^{-5}$ to about $2x10^{-3}$ have been found to be preferable. It is therefore not possible to directly correlate some of the physical parameter values recited herein with all references found in the literature. It appears clear, however, that electrical arcing, as the term is generally understood in the electrical discharge art, is not involved. Arcs may be generally categorized as high current electrical discharges, involving currents greater than one ampere or so, rather than the relatively low time-averaged currents discussed herein. (See e.g., Gaseous Electronics, Volume I, Edited by Hirsh and Oskam, pages 294-295)

It is believed the electrical discharge utilized in this invention is not sufficiently intense to displace or remove significant or substantial quantities of the plate coating. No physical change in the underlying plate surface is observed. The nature of the transformation mechanisms involved are not known. To what extent the same chemical reactions which occur in conventional imaging (e.g., photographic) processes occur during the imaging process of this invention is not known; it merely appears that the post-treatment behavior of the resulting latent image is generally similar to that of a conventionally imaged plate. It is believed that the electrical discharge forms a stream of ions which are directed into the plate coating. The interaction of these ions with the chemical compounds in the coating is believed to cause a chemical transformation in the coating which modifies the relative solubility of the coating. The term "insolubilizing effect" is used herein to mean the chemical (or whatever other) effects which such discharge treatment has on these plates which

permit such plates to be developed and used in a manner similar to conventional plates which have been exposed or imaged by conventional (e.g., photographic) methods.

Current limiting resistor 40 may be used to prevent the electrical current between the stylus 31 and the surface of plate 20 from becoming excessive. Excessive current can result in the transition of the discharge phenomenon between stylus 31 and plate 20 from the normal low current electrical discharge used in this invention to the arc discharge behavior described in the literature. Excessive current can also result in the undesirable rearrangement or removal of substantial portions of the coating on the surface of plate 20. It should be noted that the electrical discharge preferred for use in this invention is characterized by a negative differential resistance. This means that increases (decreases) in the time-averaged discharge current are accompanied by decreases (increases) in the voltage measured across the discharge gap. For example, using a gap of 0.0015 inch and the gas used in Example I, below, in a device similar to that disclosed in Figure 1, gap voltages were found to increase from 159 volts at a discharge current of 3 milliamps to 190 volts at a discharge current of 50 microamps. The use of a current limiting resistor prevents the discharge current from approaching values which would characterize an arc-type discharge. Because increasing the time-averaged current within the discharge gap also tends to increase the width of the image lines, changing the value of such resistor allows for adjustment of the width of the lines appearing on the resulting imaged plate.

The blocks designated 50, 55, 60, and 65 collectively comprise electronic circuitry which expedite the generation of a latent image on the surface of plate 20 in a timely manner from electronically stored, generated, or transmitted pattern data. Block 60 schematically depicts a

voltage source adapted to provide voltages within the range of about 200 to about 2000 volts, at current levels within a range of between about 2×10^{-6} and about 2×10^{-3} amperes. Block 65 depicts a high speed switch capable of switching the voltage generated by the voltage source 60 at the frequencies necessary for the desired image resolution or print gauge. The necessary switching frequency is of course a function of the speed at which the surface of plate 20 is traced over or scanned by stylus 31, the desired image resolution, as well as other factors, such as the delay between the application of the requisite voltage and the initiation of the electrical discharge. It has been found that, for imaging small (e.g., 10 x 15 inch) lithographic plates at a roll circumferential speed of about 12 inches per second and a print gauge of about 100 lines per inch, switching frequencies within the range of about 1.0 to about 1.5 kilohertz are necessary.

An example of one circuit which may be used in this application is shown schematically in Fig. 4. The circuit operates as follows: Data input at nodes A, B in the form of a train of +5 volt pulses are shifted from a ground reference to a bias voltage reference across nodes C, D by voltage level shifter 100. MOSFET Q2 then amplifies the output of level shifter 100, relative to the bias voltage. This results in a signal wherein the +5 volt data pulses are now on the order of +400 volts, referenced to the +250 volt bias voltage. MOSFET Q2 acts as a voltage follower, decoupling the output of MOSFET driver Q1 from the discharge gap and load resistor R_L. Voltage ${}_{JF}$ represents the buffered, amplified, shifted data output of high speed switch 65. The output voltage of approximately 650 volts is divided between current limiting resistor R_L and the gap formed between the stylus tip and the plate surface.

The circuit depicted in Fig. 4 may be any by which a logic signal of modest voltage (e.g., 5 volts) from the pattern generation means may be impressed upon a relatively high voltage d.c. bias (e.g. 250 volts). For

example, an optical coupler such as that available from Texas Instruments (of Dallas, Texas) as Model TIL 111 may be used. Use of such a bias scheme permits the stage shown in Figure 4 to achieve switching of approximately 650 volts (to ground) with only about 400 volts across the output transistors.

It should be noted that, while use of an alternating current may be used to establish and control the requisite electrical discharge, it is unnecessary to do so, and may result in reduced efficiency because the discharge polarity may only be correct for establishing an image during a portion of the a.c. cycle.

The pattern data processor represented by block 55 represents the means by which the required switching instructions dictated by the pattern data from block 50 are sent to the high speed switch 65 so that the desired pattern data is synchronized with the appropriate relative location of the stylus on the face of plate 20, and in registry with the latent image previously generated on the face of plate 20, thereby resulting in the proper initiation and interruption of the electrical discharge as the stylus sweeps over the areas of the plate intended to carry the pattern. Any suitable means for generating or retrieving such instructions may be employed. Pattern data of course may be generated manually, but in most situations electronic generation or retrieval of pattern data or switching instructions is preferred, for example, through the use of analog or digital data storage means such as magnetic or paper tape, a ROM, RAM, or EPROM, a bubble memory, etc. Appropriate data from the angular displacement sensor 16 associated with roll 10 may be input to processor 55 to facilitate the necessary task of converting the pattern data to a series of switching instructions to switching means 65, and translating instructions to translating means 38 which will result in a train of correctly timed and sequenced electrical discharges between stylus 31 and the relatively moving face of plate 20.

It is contemplated that, in addition to merely generating a series of "on-off" switching instructions which would sequentially establish and extinguish the electrical discharge in digital fashion in rigid accordance with pattern data, one may wish to modulate the electrical discharge by varying the discharge current over a range of values which lie substantially within the discharge current envelope recited herein. The range of values may be defined by a series of pre-determined discrete levels, or alternatively, may employ a more-or-less continuum of values within pre-determined limits. In either case, the desired result is the ability to vary the effective area in which the latent image-forming chemical transformation takes place within the surface of plate 20 traced by the stylus, and thereby vary the effective resolution or effective print gauge of the imaging process. Generally speaking, lower time-averaged current values result in narrower lines formed on the plate surface. By employing this method for discretely or continuously modulating the current associated with establishing or maintaining a low current electrical discharge, latent images containing well-formed lines or dots having a wide range of widths or diameters are possible. For example, lines of excellent quality and uniformity having widths of approximately five mils or more have been produced on ordinary diazonium resin plates (e.g., see Example III). Furthermore, one or more dots of almost any desired diameter within the range of the system may be generated, without the need for having to limit dot size to one of a relatively few available choices, or having to build larger "dots" from the massing or aggregation of smaller dots of uniform size, as is done in many conventional laser systems. Such capability is advantageous in producing latent images wherein extremely fine detail or half-tone graphics are desired.

As is evident from a close inspection of the data of Example III, an electrical discharge having a current value lower than some minimum value

(e.g., perhaps 10 microamps or so) does not leave a visible image on the plate of Example III. It has been observed that, when compared with completely interrupting the electrical discharge, raising the current level from a low level such as, for example, 10 microamps, to a level at which a good quality visible image is obtained (e.g., perhaps 30-40 microamps) can reduce the desired time lag (i.e., the time between the application of the requisite electrical potential between the stylus and the plate and the establishment of the electrical discharge induced thereby) over the reductions observed when only a corotron or ultraviolet light source is used.

While the above plates are conventional, photosensitive lithographic plates which may be imaged by conventional methods using a high intensity light source, it is believed that the light produced by the low energy electical discharge employed in this invention does not contribute substantially to the imaging process. The intensity of the light given off by the electrical discharge employed herein is quite modest by conventional plate exposure standards. The apparent diameter of the visible electrical discharge is much larger than the resulting line width which is produced by the discharge. No masking of non-image areas from the light generated by the discharge appears to be necessary. Sharp, microscopically well-defined boundaries may be observed between those lines traced by the electrical discharge and areas immediately adjacent to such lines, which areas have been exposed to the light of the discharge, but not to the discharge itself. It is believed the experiment described in Example II indicates that the light of the discharge is not a principal or primary contributor to the insolubilizing effect which the discharge is observed to have on conventional diazonium resin plates.

Following the operation of one embodiment of this invention, pattern data information generated or stored in data source 50 is fed to pattern

data processor 55, which receives the instructions along with data on the rotational position of roll 10 from angular displacement sensor 16. Processor 55 then generates two sets of instructions. One set of instructions is sent to translating stage 38 to assure correct placement of the imaging stylus along the axis of roll 10. A second set of instructions is sent to high speed switch 65 to generate the train of voltage pulses necessary to establish the sequence of electrical discharges which serve to image the plate with the desired pattern information.

The current sent from switch 65 passes through R_L, a load resistor which serves to limit the direct current delivered to stylus 31, which stylus may be precisely spaced from the surface of plate 20 by means of a micrometer assembly 37 or other means. For most plates imaged using the process disclosed herein, the voltage impressed upon stylus 31 is electrically positive with respect to the plate, although in some cases, a negative stylus polarity may be preferred.

Imaging assembly 30 is traversed across the face of plate 20 by translating stage 38. As a part of imaging assembly 30, gas means 36 introduces a controlled quantity of a relatively inert gas such as argon or a mixture of helium and neon into the discharge gap, i.e., the region between stylus 31 and the surface of plate 20. Ionization promotion means 34 is also directed toward the region between stylus 31 and the surface of plate 20 for reasons discussed above. Motor 5 is used to turn roll 10 at a constant rate via belt 7 thereby allowing stylus 31 to scan over the entire surface of plate 20, which is temporarily but securely attached to the perimeter of roll 10, and allowing the electrical discharge to sweep over all pattern areas on the plate. By establishing and controlling the requisite electrical discharge in the pattern or image areas of, for example, diazonium resin plates under these conditions, the plate surface in those areas becomes resistant to (i.e., relatively insoluble in) the

developing materials used in developing such plates. These plates, imaged by the electrical discharge process of this invention, may thereafter be developed using conventional developing techniques.

The electrical discharge employed in this invention has been used to place a latent image on a variety of commercially available, lithographic-type printing plates under a variety of operating conditions, as may be determined from the following illustrative examples, which are not intended to be limiting in any way. Additive-type plates have been found to be particularly suitable for use in connection with this invention.

EXAMPLE 1

An apparatus similar to that schematically depicted in Figure 1 was used, in accordance with the following specifications:

Plate: 3M "R", a negative working, additive-type photosensitive plate distributed by 3M Corporation, St. Paul, Minnesota, conventionally mounted with the metallic plate surface electrically grounded to the electrically conductive roll via conventional conductive fastening pins attaching the plate to the roll.

Stylus: Tapered, sharpened steel needle having a maximum diameter of 0.025 inch, and a tip radius of approximately 0.001 inch. The stylus tip is spaced approximately 0.003 inch from the plate surface. The stylus shank is embedded in a plastic sheath with a channel provided for the delivery of gas to the discharge area, as depicted in Figures 2 and 3.

Gas: Mixture of 10% helium, 90% neon, fed through the configuration indicated in Figures 2 and 3 at a flow rate of 1.6 g/minute.

Breakdown Promotion Means: A corotron, comprised of a section of tungsten wire 1.3 inches long and 0.004 inch in diameter, centered along the axis of a halved section of aluminum tubing approximately 1.5 inches in length. The wire is energized with 2 milliamps at 7 kilovolts. The corotron is positioned in close operable proximity (approximately one inch) to the stylus tip and plate surface.

Current Limiting Resistor (R_L): 6.3 Megohms, 0.5 watt.

High Speed Switch: Similar to that depicted in Figure 4.

Source of Pattern Data: EPROM, with appropriate associated electronics of conventional design.

With the above-specified apparatus, the plate was continuously rotated on the roll with a roll circumferential speed of approximately 12 inches/second. Ambient light in the vicinity of the apparatus was subdued to prevent fogging of the photosensitive plate. Applied voltage and time-averaged current values during the electrical discharge period were maintained at 650 volts and 80 microamps, respectively, with the polarity of the voltage on the stylus being positive with respect to the grounded plate roll. The stylus was slowly and automatically traversed along the axis of roll rotation at a rate of approximately 0.2 inch/minute, thereby

causing the stylus to trace a closely spaced helical path on the plate surface. The desired pattern was adapted from a standard lithographic diagnostic pattern, requiring both solid areas and minimum dot diameters of approximately 0.005 inch. The maximum switching frequency was about 2.5 kilohertz.

After the latent image of the desired pattern was created on the coated surface of the plate by contact with the electrical discharge, the plate was removed from the roll and developed conventionally, i.e., the plate was treated with process gum (R Process Gum, a product of 3M Corporation of St. Paul, Minnesota), and then with a lacquer developer (Reliable Red Lacquer Developer, distributed by Anchor/Lithkemco of Hicksville, New York) for image reinforcement. During the development process, the areas contacted by the electrical discharge behaved similarly to areas on similar plates imaged conventionally, i.e., photographically via actinic light. The resulting developed plate exhibited visually outstanding detail, with excellent solid areas, distinct lines having a width of approximately 8 mils, and no background. The plate was then placed on a sheet fed offset lithographic duplicator of conventional design. The ink chosen was Multilith SF Ink, Standard Black (SF-10-C), distributed by AM Multigraphics of Mt. Prospect, Illinois. The dampening solution was 3M Duplicator Fountain Concentrate, distributed by 3M Corporation of St. Paul, Minnesota, diluted as directed (1-15 parts by volume). The paper chosen was a conventional white business paper having a basis weight of 20 pounds, distributed by International Paper Company.

The first sheets to be printed carried an exceptionally clear and detailed image corresponding to the areas of the plate contacted by the electrical discharge, with uniform, saturated solid areas, well-formed dots of the desired size, and no background. The press was run, with customary adjustments, until 20,000 sheets were printed. The last sheets to be

printed were visually substantially indistinguishable from those printed at the beginning of the press run.

EXAMPLE II

The plate of Example I was rotated on the device of Example I, except that the stylus was replaced by a pair of styli each spaced approximately 3 mils from the plate surface and approximately 2 mils from each other. A single 2.2 megohm resistor was placed in series with each stylus. A voltage of approximately 1000 volts was impressed across the stylus/resistor pair which resulted in a strong visible glow between the stylus tips, but no visible discharge to the plate. The plate was developed as in Example I (i.e., conventionally, as if having been exposed to actinic light). No image was observed on the plate, indicating that the light from the observed glow visible discharge was insufficient to cause imaging of the plate.

EXAMPLE III

The plate of Example I was imaged and developed in accordance with the teachings of Example I, except that the resistance values for the current limiting resistor R_L were varied over a range which permitted monitoring of current in the discharge region. The associated image quality and line width achieved (based upon reproduction of a series of spaced parallel lines) is given below.

R_L (Megohms)	Measured Current (microamps)	Image Quality
0.2	2410	Poor, with line width varying from 18 to 75 mils
0.4	1110	Poor, with line width varying from 15 to 35 mils
1.0	434	Excellent, with uniform lines approximately 14 mils wide
5.0	84	Excellent, with uniform lines approximately 9 mils wide
10.0	41	Excellent, with uniform lines approximately 6 mils wide
15.0	28	Fair, with lines approximately 4 mils wide
22.0	21	Poor, with lines approximately 3 mils wide
44.0	9.5	No visible image

EXAMPLE IV

The procedures of Example I were followed, except that the plate used was an LKK "wipe-on" type plate, using LKK "Wipe-O" Sensitizer Base and LKK "Wipe-O" Sensitizer Powder, all distributed by Anchor/Lithkemco of Lynbrook, New York. The plate was developed in accordance with the distributor's instructions, using the distributor's developing chemicals. The image obtained on the plate was well defined, with excellent contrast and resolution. The plate was used to print several hundred copies, each carrying an excellent printed image.

EXAMPLE V

The procedures of Example I were followed, except that the plate used was a Citiplate Custom 10, distributed by Citiplate, Inc. of Jackson, Tennessee. A negative polarity on the stylus was used. The plate was developed in accordance with the distributor's instructions, using the distributor's developing chemicals. The image obtained on the plate was

well defined, with excellent contrast and resolution. The plate was used to print several hundred copies, each carrying an excellent printed image.

EXAMPLE VI

The procedures of Example V were followed, except that a positive polarity on the stylus was used, and process gum was used as part of the developing process. Results generally similar to those of Example V were achieved.

EXAMPLE VII

The procedure of Example I was followed except that the plate used was a Kodak POLYMATIC S plate, a photopolymer plate distributed by Eastman Kodak Co., of Rochester, New York. The plate was developed in accordance with the distributor's instructions, using the distributor's specified chemicals. The image on the plate was well defined with good contrast.

EXAMPLE VIII

The procedure of Example I was followed except that the plate used was an Agfa Gevaert COPYRAPID diffusion transfer plate, distriubted by Agfa Gevaert, Inc. of Teterboro, New Jersey. The plate, using conventional imaging techniques, is not exposed to light during the imaging or developing process. The plate was imaged using the invention disclosed herein, and was developed in accordance with the distributor's instructions using the distributor's specified chemicals. The image on the plate was well defined, with excellent contrast and resolution.

CLAIMS

1. A method for creating a desired latent image on a substrate surface carrying a layer capable of undergoing a change in relative solubility when acted upon by a low current electrical discharge to form a latent image thereon which thereafter may be developed for use in a lithographic-type printing process characterеised by contacting areas of said layer corresponding to said image with a low current electrical discharge in the presence of a relatively inert gas, said discharge being of sufficient energy density to induce a change in the relative solubility of said layer to a lithographic-type developing material in said areas.

2. The method electrically conductive substrate surface of claim 1, characterised in that said layer comprises an unimaged photosensitive material carried on an L and that areas of said layer corresponding to said image are swept with a low current discharge of sufficient energy density to insolubilize said layer in said areas.

3. The method of claim 1 or 2, characterised in that said layer comprises an unimaged water-soluble coating containing a diazonium resin carried on an additive lithographic-type printing plate.

4. The method of any of claims 1 to 3, characterised by the steps of:

a) positioning an electrode in close proximity to said surface, thereby forming a discharge gap;
b) introducing a relatively inert gas into said gap;
c) initiating a low current electrical discharge between said electrode and said surface; and

(d) maintaining the time-averaged current flow within said discharge gap to a value sufficient to induce an insolubilizing effect in said layer.

5. The method of claim 4 characterised in that said value of the time-averaged current flow within said discharge gap is between $2x10^{-6}$ and $2x10^{-3}$ amperes.

6. The method of claim 4 or 5, characterised in that said electrode is scanned over said surface by relative movement between said electrode and said surface, and said time-averaged current flow is maintained at said value only while said electrode is opposite areas of said surface wherein said insolubilizing effect is desired.

7. The method of claim 4, 5 or 6 characterised in that said current flow is limited to a maximum value which is insufficient to displace said layer so as to substantially expose said substrate under said layer.

8. An apparatus for creating a latent image on an unimaged substrate surface by a method according to claim 1, characterised by:

(a) a voltage source (60);

(b) electrode means (31) connected to said voltage source;

(c) switching means (65) associated with said voltage source for controlling the voltage on said electrode means;

(d) gas means (36) for introducing a gas into the region between said electrode means and said substrate surface;

(e) current limiting means (40) for limiting the electrical current flowing through said electrode to values less than $2x10^{-3}$ amperes;

(f) carriage means (10) for positioning said coated substrate surface opposite to and in close proximity with said electrode means; and

(g) transport means (5, 7) for causing relative movement between said electrode means (31) and said substrate surface.

9. The apparatus of claim 8 further characterised by pattern data processing means (55) for generating switching instructions for said switching means.

10. The apparatus of claim 8 or 9, characterised in that said electrode means (31) is positioned closer than 0.01 inch from said substrate surface.

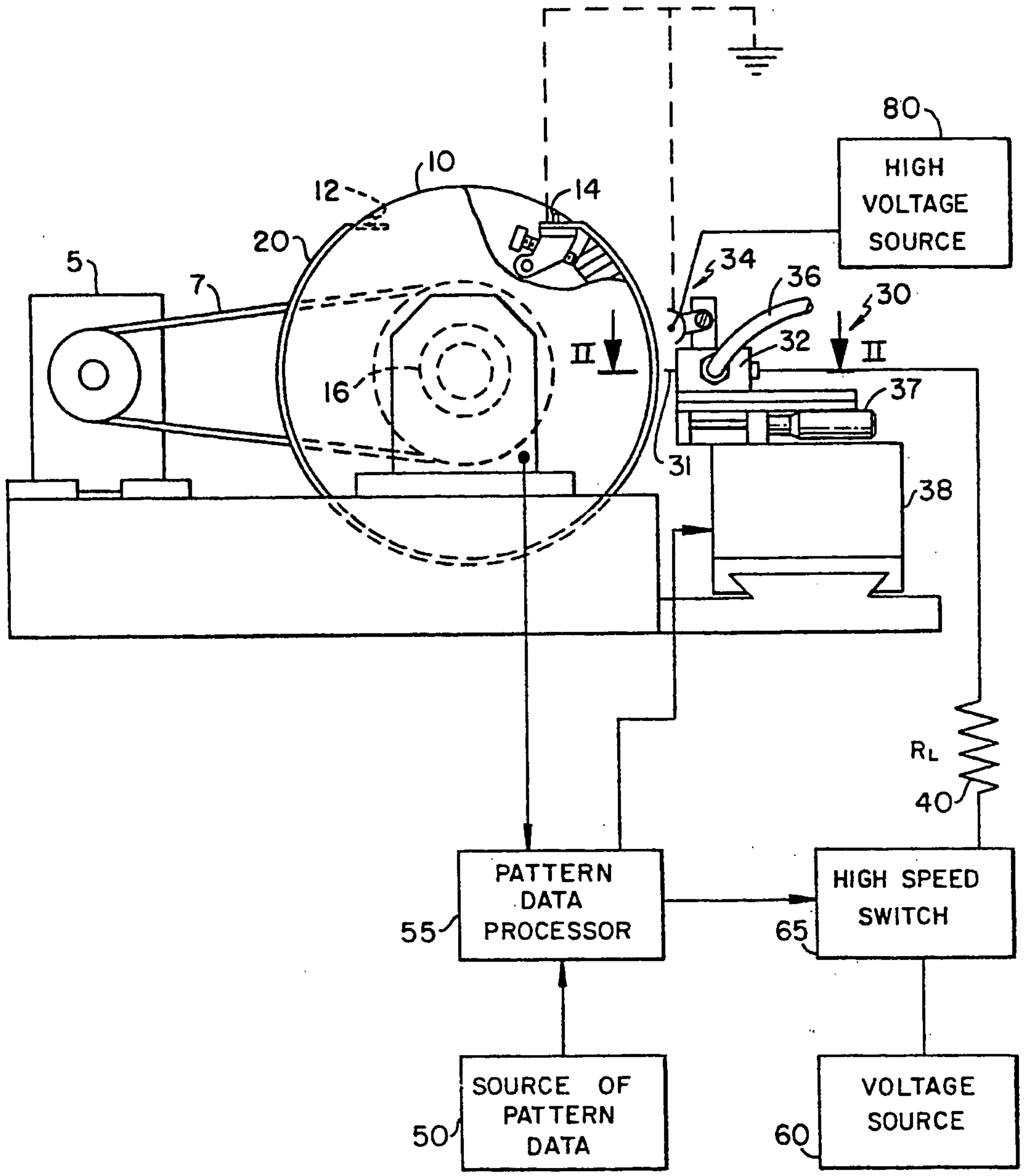

80
HIGH VOLTAGE SOURCE
10
12
14
20
5
7
34
36
30
32
II
II
37
16
31
38
RL
40
PATTERN DATA PROCESSOR
55
HIGH SPEED SWITCH
65
SOURCE OF PATTERN DATA
50
VOLTAGE SOURCE
60

FIG. - 1 -

0130028

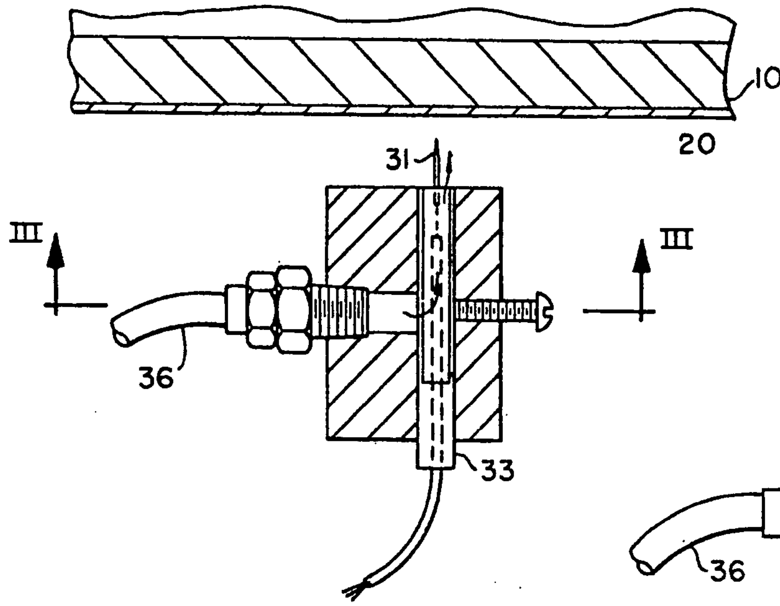


FIG -2-

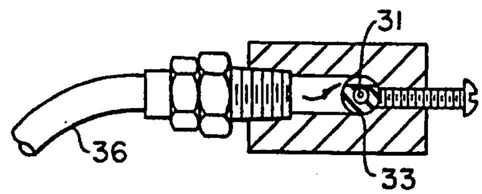
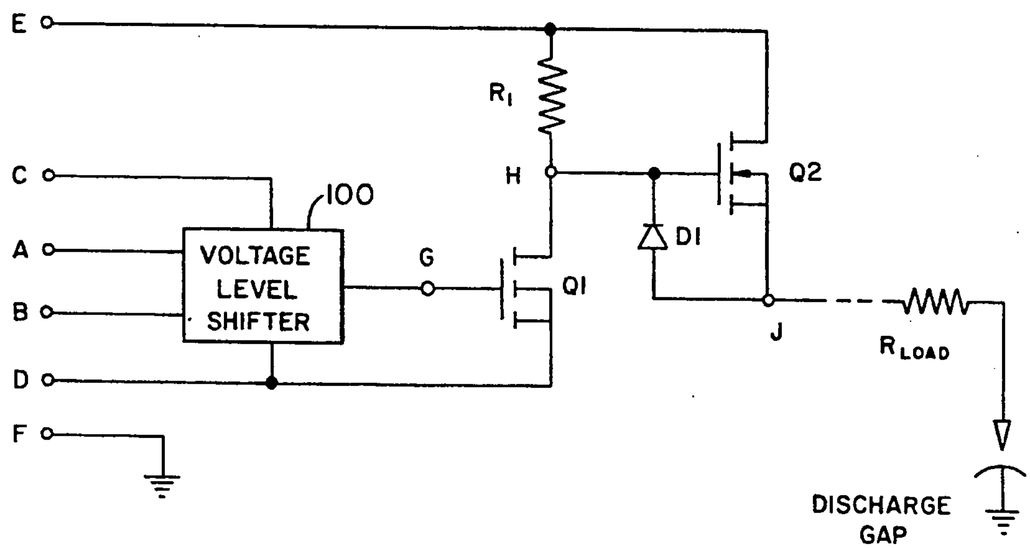


FIG. -3-



V_{ED} = HIGH VOLTAGE
V_{DF} = BIAS VOLTAGE
V_{AB} = DATA (PULSE TRAIN)
V_{CD} = BIAS + PULSE VOLTAGE LEVEL
V_{GD} = SHIFTED DATA
V_{HD} = AMPLIFIED SHIFTED DATA
V_{JF} = BUFFERED AMPLIFIED SHIFTED DATA

FIG. -4-